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PROGRESS IN PRESTRESSED CONCRETE  
CONSTRUCTION

by J. F. Jelley, M. ASCE

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PROGRESS IN PRESTRESSED CONCRETE  
CONSTRUCTION

by

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I appreciate the opportunity to comment on today's program. This task is becoming a pleasant annual chore for me, and I have enjoyed listening to the fine papers that have been presented. Although the title of my talk is "Progress in Prestressed Concrete Construction", I am not going to cover the same ground that Professor Holley so ably described in his comprehensive and imaginative review. I wish to point toward future progress rather than discuss past performances.

I want to express my sincere appreciation to the authors of the papers presented today. They furnished me with copies of their presentations well in advance so I had ample time to review them. In addition, Mr. Arsham Amirikian and Commander Stanley Rockefeller of the Bureau of Yards and Docks also reviewed the papers and furnished me with valuable comments. This made my task much easier. I am truly grateful to the authors and to my associates in the Bureau for their cooperation. I also wish to compliment Mr. Wuerpel,

the Chairman of the Program Committee and his Committee for arranging such a well balanced program which ranges from research, through design, to construction.

The M. I. T. Symposium last year aroused great interest in the progress of prestressed concrete construction in this country. My closing comments at that Symposium were optimistic. Perhaps I was carried away by the enthusiasm which permeated that Symposium. I felt that the trend toward utilization of prestressed concrete, which appeared to be shaping at that time, would be definitely established within a short period. I had hoped that there would be a number of important projects in prestressed concrete, particularly in building construction. To be frank, my hopes and expectations have not been realized.

I am sure I was too optimistic at that time, but after listening to Professor Holley's excellent review of activities for the past year, I feel much more encouraged. While the number of projects undertaken is still relatively small, he has pointed out that the increase in the use of prestressed concrete has been ten-fold. This is substantial evidence of the wide-spread interest in this new method of construction.

I was even more impressed by his remark that there were now 34 plants set up to produce prestressed members on a production basis. This augurs well for the future.

There appears to have been very little change in the past year regarding the division of opponents and proponents of prestressing. For lack of actual execution of important projects, the advocates of prestressed concrete have not won many supporters from those who have remained on the sidelines. To some of the doubters the question of economy, the most essential factor in the production of prestressed concrete, still remains to be conclusively demonstrated. To others, there are still some questions regarding the adequacy of the methods of prestressing. To still others, there are the problems of adaptation of existing design and framing concepts to the available arrangements of prestressing. However, the past two years have seen a very high level of construction activity, a level that would warrant much greater use of prestressing. Funds have been plentiful. It has been a period where jobs and funds await the contractor. Why is not this the time to perfect new techniques and materials? Is necessity the only condition that can drive Americans toward more economical construction and a more proper use of materials? But all in all, as

Professor Holley so aptly remarked in conclusion, "This has been a year of progress".

Five principal points impressed me as I reviewed the papers. And again as I listened to their presentation today. First, a few large and important American projects have been accomplished. We have passed beyond the small projects which were discussed last year into the field of larger and more important utilization. The Tampa Bridge described by Mr. Dean, and the New York Pier 57 described by Captain Praeger are examples of such projects. Both of these structures were susceptible to mass production techniques which undoubtedly led to the adoption of prestressing.

While we have come to expect large projects in this country, I feel sure that some of you were surprised to hear of the large and important bridge constructed in Caracas, Venezuela, which was so ably described by Mr. Shama. I have gained the impression that some American engineers suffer from a superiority complex and feel that the other countries of the World are "backward". Perhaps Point Four has fostered this impression. I would like to make sure that such engineers clearly understand that the Caracas Bridge

is but one example of the many advanced and daring concepts in the use of concrete that have been utilized in South America. I want to give due credit to E. Freyssinet but South American engineers are progressive and they could well regard the United States as "backward" when it comes to concrete design.

Another point that impressed me was the indication that prestressed concrete is becoming competitive with the older materials and methods of construction. The description of the Tampa Bridge indicated that conventional methods of construction were considered and actually bid on as alternates. Mr. Rundlett's description of the Endicott Street Bridge gives most interesting cost figures, and indicates that while that particular bridge was not competitive, the margin of cost was so close as to justify more bridges of this design. The utilization of a large number of prestressed beams on New York Pier 57 was undoubtedly the result of a study of competitive materials. In this connection I was interested to hear the comments of Roger Corbetta, the contractor on this job. He felt that in this case, the prestressing technique was much simpler than placing reinforcing bars. Reinforcing bar cages could not

be assembled as rapidly as wire could be pulled into the beam forms on a production line basis.

The next point that impressed me was the fact that the use of prestressing for special purposes undoubtedly will enhance the art. For example, Mr. Shama described use of prestressing to take care of temporary stresses during construction of Caracas Bridge. In many instances the use of prestressed concrete will be dictated by special considerations in which economy may not necessarily be the deciding factor. As a matter of fact, in some cases we will be willing to spend a little more for obtaining a quality of product or assuring a certain property of materials which may be required by service or performance conditions. The heavy forge foundation described by Klein and Crockett is a good example of such a case. Here prestressing is introduced to improve the fatigue resistance of concrete. Unquestionably there will result an ultimate economy in maintenance costs. I am conscious of the importance of such considerations because I am charged with the over-all responsibility of maintenance care of the Navy's vast shore installations. It has been our painful experience to discover that the temporary advantage gained in lower

initial cost by the use of certain types of materials sometimes vanishes completely due to extensive repairs needed during the service life of the structure.

Still another point that has been brought out today, which was of particular interest to me, was the fact that savings in steel, particularly structural steel, can be expected from the use of prestressed concrete. The saving of structural shapes has been particularly important during the past two years when the construction industry has been operating under a system of priorities and allocations. Mr. Dobell's description of prestressed girders in the Manhattanville College is an excellent example of the use of prestressed concrete as a substitute material. Mr. Rundlett also noted that the Endicott Street Bridge would normally have been built of structural steel. It was interesting to note that the length - depth ratio of the prestressed beam is closer to that of structural steel than reinforced concrete in both the Manhattanville College and Endicott Street Bridge girders. I am deeply interested in the use of alternate materials since the Bureau of Yards and Docks normally has its largest building construction programs in time of emergency. We must anticipate the existence of critical material shortages

in such times. We must plan for the use of alternate materials in these programs. Prestressed concrete undoubtedly will fulfill this requirement.

A point that particularly intrigued me was the successful solutions of construction problems. I could not help but think that a hundred years ago, in 1852, such solutions would have been regarded as trade secrets and carefully guarded by the contractors of that day. The fact that our speakers were frank in telling of their experiences is certainly going to give contractors on future work much more confidence. Messrs. Crockett and Klein's several solutions of construction details arising in the construction of the forging hammer foundation, as well as the problems arising on the Tampa Bridge and the Manhattanville College, should be of great interest to the contractor.

Finally, I noted more symptoms of a condition that has disturbed me during the past few years. I have noted that our contractors today are most reluctant to accept new methods and new ideas. In our Navy experience, we have frequently asked for bids on alternate methods of construction. Almost invariably the contractor will concentrate his efforts on the older methods and will put

high prices on new methods of construction. I have come to the conclusion that the only way we can get contractors to bid on new methods of construction is to include no alternate bids permitting other methods. Mr. Rundlett's paper cited a good example. I was struck by the fact that the lowest bidder on the construction of the prestressed beams was not a building contractor but was a concrete pipe manufacturer. The high bid of contractors for the placing of material with which they were not familiar was also typical. Symposiums, such as we are participating in today, will go far towards encouraging our engineers and contractors to use these new methods of construction without fear or hesitation.

Undoubtedly, there are other interesting features in today's papers that warrant recognition, including Mr. Klein's effective use of prestressing to improve the fatigue resistance of concrete. I have mentioned those that were of most interest to me. But, the papers also appear to high-light future progress in the art of prestressing.

There is always room for improvement in the design, mechanics, and materials of prestressing. Some of the needed improvements must come from the designer and the

builder in the form of efficient designs and ingenious arrangements. Others, pertaining to the quality of steel and concrete, must come from the technologists and the Metallurgists. Laboratories, on their part, should collaborate on various theoretical phases of the problem. To be more specific, we will need a concrete of much higher strength than we are presently using in our work. We need a steel of greater yield and more defined stress-strain relation than is available at the present time. We need new arrangements in which continuity can be fully applied through simpler devices of anchorage and stressing.

There must be a closer association between design work in the office and execution in the field. Bright ideas, without practicability, will remain valueless. In most cases, the success and the economy of new developments will depend on the degree of cooperation obtained during the design and construction stages of the project. A great part of the desired improvements must come through the joint efforts and skills of the designer, inventor and the constructor.

It was encouraging to note that there is a continuing development of new systems of prestressing. The

systems with the most publicity a year ago now have strong competitors. In Captain Praeger's beam design for Pier 57, use is made of the principal of pretensioning. This is an application not commonly utilized in this country. The main advantage of this method is of course, the elimination of end anchorage by employing bond. As an aside, it is interesting to note that the tests reported by Mr. Janney verified the dependability of bond obtained from smooth surface rods and wires of relatively small diameter.

In my talk last year, I mentioned that I felt that the competitiveness of prestressed concrete had been adversely influenced by patents in the past. I still feel that if wide-spread adoption of this technique is to be obtained, it will be necessary to make the devices of anchorage and methods of prestressing available to the construction industry without the burden of heavy royalties. Little progress has been made in making patented material freely available. However, competitive methods have been developed. I feel in the long run the pressure of competition will force the reduction of patent royalties.

Our future progress is dependent upon research.

It was most encouraging to hear Dr. Newmark's philosophical discussion of the problems of research, and the active program of research described by Mr. Janney.

Dr. Newmark enumerated a number of actual unknowns or rather unattacked problems which require research before the prestressing technique is applicable to other fields.

I was interested to note that the question of research was not forgotten by some of our participants. Mr.

Rundlett mentioned that instrumentation had been provided in the Endicott Street Bridge which will permit further study by M. I. T. The action reported by Mr. Dean of allowing the University of Florida to carry out some of the tests and publish the results was also praiseworthy.

Mr. Dean also reported on tests that were made in connection with design of the Tampa Bridge to determine the value of bond strength. These independent actions are valuable but a long range coordinated program, such as that undertaken by the Portland Cement Association, is absolutely necessary. Mr. Janney has rendered an interim report on this comprehensive program. Without a doubt this will insure a better product in the future, but as Dr. Newmark points out, that is only phase two -

laboratory experience. It is lost without observation and field experience. More research is needed, particularly that planned on a programmed basis, and such programs should undoubtedly include a long term study of performance.

Lest any of you get the impression from the papers on research that we do not have enough knowledge to proceed at this time, I want to emphasize that there is sufficient basis for adequate and economical design now as the accomplished work to date has proved. In fact the research in progress indicates that designers have been too conservative up to now.

I also feel that an impression is being created that prestressed design is beyond the capacity of most engineers. This feeling naturally has not been conducive in providing opportunities for greater application of the technique. A favorable condition for future progress can be created by removing the design of prestressed concrete structures from the currently accepted field of over-specialized work.

While discussing design, I want to point out that while all of the applications we have heard described today utilized simple beams, we must look towards

continuity in design. We can not abandon our advance design concepts to use simple prestressed framing arrangements. I can not agree that the only practical prestressed design is the use of a series of simple beams and isolated elements in an integrated framing.

In some of the applications described today it appeared possible to effect further savings by introducing continuous beams where the live load was an appreciable factor. But I have noticed that most designers are conservative. They prefer to learn to walk before they begin to run. I'm sure our designers are now learning to walk firmly as far as prestressing is concerned.

Many factors may have dictated the use of simple beams. However, the quality of design gained in the area of rigid framing and continuous structures in the past three decades must not be sacrificed in the introduction of prestressing in future design. The understandable motive of simplicity must not prevail over considerations of efficient design where optimum use is made of materials of construction. I was greatly encouraged that three of the speakers, Professor Holley, Dr. Newmark and Mr. Dobell recognized that we must look forward to advances in design and not restrict the use of prestressing to simple beams. The use of a fully prestressed

rigid framing remains a challenging task yet to be accomplished. Our engineers must devise newer and more ingenious arrangements where the advantages of both continuous framing and prestressed design can be maintained.

I have enjoyed our Joint Session today. I am sure you have too. The papers have been provocative and have covered interesting applications of the prestressed technique. I feel that the American Concrete Institute and the American Society of Civil Engineers have rendered a great service by scheduling this Joint Meeting in connection with the Centennial of Engineering. This large audience has proved wisdom of their decision. I certainly hope that these Societies will continue the important basic work now underway in their technical committees and that they will schedule future Symposiums that will accelerate the interest of the profession in the art of prestressing.

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